

Clinical comparative study between Magnesium sulphate versus Rocuronium versus Dexmedetomidine as adjuvants for local anesthetic in peribulbar block for eye surgeries

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Abstract

Background: Regional anesthesia is a preferred technique for ophthalmic surgery. It is safe, inexpensive and provides efficient ocular anesthesia for ophthalmic surgery. It is associated with less hemodynamic instability, less respiratory depression, better postoperative pain relief, and less nausea and vomiting compared to general anesthesia.

Objectives: The aim of the study was to compare the safety and efficacy of the use of Magnesium sulfate versus that of Rocuronium versus Dexmedetomidine as an adjuvant to the local anesthetic in peribulbar anesthesia. It is characterized by generating optimal operating conditions for eye surgery in terms of akinesia, analgesia, incidence of complications, as well as induction of patient and surgeon satisfaction.

Patients and Methods: The present study included 100 patients of the American Society of Anesthesiology (ASA), physical status I, II, III or IV of both sex, (20-80) years old and undergoing to anterior and posterior segment surgeries. Informed written consent from all patients was taken after approval of Al-Azhar University Ethical Committee.

Results: Evaluation of the globe akinesia was done at (2.5), (5), (7.5), and (10) min. after injection. The onset of motor block showed a statistically significant difference between the four groups, the rocuronium group showed more rapid onset of motor block than dexmedetomidine group then magnesium sulphate group then lastly the control group.

Conclusion: The present study concluded that using Rocuronium as an additive to local anesthetic drugs in peribulbar block it makes onset of block more rapid and dense but it has less effect on analgesic aspect. On the other hand, when Dexmedetomidine or Magnesium sulfate were used as additive they increased analgesic effect of local anesthetic and decreased the need for early postoperative rescue analgesia, as well as fastening the onset of block but to a lesser extent less than Rocuronium as an additive to local anesthetic.

Keywords: Magnesium sulphate, Rocuronium, Dexmedetomidine, local anesthetic, peribulbar block, eye surgeries.

INTRODUCTION

Regional anesthesia is a preferred technique for ophthalmic surgery. It is safe, inexpensive and provides efficient ocular anesthesia for ophthalmic surgery. It is associated with less hemodynamic instability, less respiratory depression, better postoperative pain relief, and less nausea and vomiting than general anesthesia⁽¹⁾.

Among regional blocks, peribulbar block is safer in comparison with retrobulbar block due to the lesser incidence of serious complications such as brain stem anesthesia, globe perforation, and retrobulbar hemorrhage⁽²⁾.

Peribulbar block is a much simpler, rapid, and safe technique; especially in elderly patients who have multiple systemic diseases such as diabetes or cardiovascular disease that may limit the use of systemic analgesics⁽³⁾.

Peribulbar anesthesia is widely used for cataract surgery. However, it has the disadvantages of slowing the onset of orbital akinesia and the frequent need for block supplementation. To overcome these limitations, many adjuvant drugs such as adrenaline, sodium bicarbonate, and hyaluronidase have been added to the local anesthetic mixture used for peribulbar block to augment its efficacy and hasten its speed of onset. However, their effects have been variable⁽²⁾.

These agents are also not devoid of side-effects like allergic reaction, bradycardia, sedation, dryness of mouth, systemic neuromuscular blockade, etc. Until date, no one adjuvant is ideal for peribulbar block⁽⁴⁾.

Neuromuscular blocking drugs, such as vecuronium and atracurium, have also been

added to the local anesthetic mixture and have been shown to improve the quality of peribulbar anesthesia ⁽⁵⁾.

Atracurium, however, has histamine-releasing properties and could result in undesirable local hyperemia (Dose more than 5 mg). In contrast, rocuronium is devoid of this adverse effect and has a faster onset of action; its effects in a low dose on the quality of peribulbar anesthesia (onset time and need for supplemental injection of local anesthetics) have not been fully explored ⁽⁶⁾.

Magnesium sulfate has been used for many years on an empirical basis to control convulsions in patients with pre eclamptic toxemia. Magnesium ions are essential for many biochemical reactions, and a deficiency may produce clinically important consequences. Many of its pharmacological properties have only recently been appreciated (like its action as bronchodilator and its sedative effect) ⁽⁷⁾.

Magnesium is a physiological calcium channel blocker and noncompetitive antagonist of N-methyl-D-aspartate (NMDA) receptors.

Magnesium has been used with a local anesthetic solution in different regional anesthesia technique to decrease the onset time of block and to increase the quality and duration of anesthesia ⁽⁴⁾.

Dexmedetomidine is a centrally acting, highly specific α_2 –agonist that has been used as an additive to local anesthetics in peripheral nerve block, brachial plexus block, and spinal anesthesia to shorten the onset and prolong the duration of analgesia ⁽⁸⁾.

Dexmedetomidine has some advantageous pharmacological characteristics as it achieves more hemodynamic stability especially for patients with cardiovascular diseases, compared to other vasoconstrictors such as epinephrine. It has potential as a new safety adjuvant to LAs as it is preservative free and has no added chemicals. Dexmedetomidine may be used to improve the reliability and efficacy of regional anesthesia as it is useful in peripheral nerve blocks in patients with chronic pain ⁽⁹⁾.

PATIENTS AND METHODS

I- Patients

The present study included 100 patients of the American Society of Anesthesiology (ASA), physical status I, II, III or IV of both sex, (20-80) years old and undergoing to

anterior and posterior segment surgeries. Informed written consent from all patients was taken after approval of Al-Azhar University Ethical Committee. Patients were randomly allocated into four equal groups (25 patients in each group):

- **Group O** (control group): undergone peribulbar block using 9ml of local anesthetic: 4.5 ml of 0.5% bupivacaine and 4.5 ml of 2% lidocaine mixed with hyaluronidase (150 U) + 0.9% saline (1 ml).
- **Group M**: undergone peribulbar block using 9ml of local anesthetic: 4.5 ml of 0.5% bupivacaine and 4.5 ml of 2% lidocaine mixed with hyaluronidase (150 U) + 50 mg magnesium sulfate in 1 ml of 0.9% saline.
- **Group R**: were undergone peribulbar block using 9ml of local anesthetic: 4.5 ml of 0.5% bupivacaine and 4.5 ml of 2% lidocaine mixed with hyaluronidase (150 U) + 0.06 mg/kg rocuronium (maximum 5 mg) in 1 of 0.9% ml saline.
- **Group D**: undergone peribulbar block using 9ml of local anesthetic: 4.5 ml of 0.5% bupivacaine and 4.5 ml of 2% lidocaine mixed with hyaluronidase (150 U) + 1 mcg /kg dexmedetomidine in 1 of 0.9% ml saline.

- Inclusion criteria:

- Age: (20-80) years.
- Both genders are eligible.
- ASA class (I, II, III or IV) patients.
- Axial eye length ranged from 22 to 28 mm.

- Exclusion criteria:

- Patient refusal.
- Local sepsis.
- Trauma or perforated globe.
- Patients with hypersensitivity to local anesthetics.
- Patients on anticoagulants or prolonged coagulation profile (INR not more than 2.5).
- Patients with inability to lay flat, intractable cough, communication barrier (language, deafness) and neurological diseases.

Materials

1) Drugs:

- Topical anesthetic: Benoxinate Hcl drops 0.4% (Benox, Epico, Egypt).
 - LidocaineHcl2% (Debocaine, AL-Debeikypharma, Egypt).
 - Bupivacaine Hcl0.5% (Bucain, Delta Select, Germany).
 - Hyaluronidase (Wydase, 15IU/ml, Wyeth, Lab, Philadelphia PA).
 - Magnesium sulphate (100mg/ml, Epicopharma, Egypt).
 - Rocuronium (50mg/5ml,N,V.Organon,Nethe rland)
 - Dexmedtomedine (Dexmedetomidine200 mic/2ml, Hospire inc., lake forest, USA)
- 2) Needle size: 25 gauge.
 - 3) Intravenous cannula 22 G. was inserted in the dorsum of the hand (preferred site) for intravenous access and sedation to the patients.
 - 4) Drugs for premedications: intravenous midazolam (5mg/ml, Mediathetic, Amoun, Egypt)(0.01mg/kg) and Fentanyl Citrate (50µg/ml, Fentanyl-Janssen, Belgium) was administrated at 5minutes before the block.
 - 5) A nasal catheter was used for humidified oxygen supply at a rate of 2litre/min.
 - 6) Monitors for vital signs: Electrocardiograph (ECG), non-invasive blood pressure (NIBP), heart rate (HR) and oxygen saturation (SpO₂), respiratory rate (RR).
 - 7) Anesthetic machine, resuscitation equipment and drugs.

II - Methods

Patients included in the study after proper pre-operative assessment.

Preoperative evaluation:

A) History:

B) Examination:

for eye appearance, local infection and ocular movement.

C) Investigations:

Complete blood picture, coagulation profile, fasting and post-prandial blood sugar, liver enzymes, urea and creatinine were assessed.

Monitoring

All patients undergoing any eye surgery under local anesthesia were monitored with pulse oximetry, ECG, non-invasive blood pressure measurement. Patients received an oxygen-enriched breathing atmosphere to prevent hypoxia and at a flow rate enough to prevent re-breathing and the ensuing hypercarbia once draped. ECG and pulse oximetry were continued and recorded every 15 min during the entire procedure and every 30 minute during the first two postoperative hours.

Techniques

1-Patient Position and general preparation for all patients:

The patients should be comfortable and soft pads are placed under the pressure areas. All patients were placed in supine position with resting the head on a small pillow and were asked to look in the primary gaze position. The face of the patient was swabbed with an appropriate cleansing solution, paying attention that surplus solution should not flood into the eye. Each stage of the block was accompanied by verbal contact with the patient.

2-Painless local anesthetic technique:

“Painless local anesthetic solution” was injected in the inferotemporal quadrant. After gently retracting the lower eyelid with a finger, the tip of 25G, 12mm needle enters inferotemporally just posterior to posterior tarsal plate with the shaft of the needle arranged tangentially to the globe. Following test aspiration, the initial injection is 1ml “painless local” The needle has easily and painlessly (because of preliminary topical anesthesia drops) penetrated the conjunctiva.

3-Peribulbar block technique:

There were four groups; the patients were divide randomly into four groups (25 patients in each group) according to the medications they received.

1- Classic controlled group (O): (25patients).

They received 9 ml of the local anesthetic: 4.5 ml of 0.5% bupivacaine and 4.5 ml of 2% lidocaine mixed with hyaluronidase (150 U) and 1ml of normal saline which was divided equally in both inferotemporal and medial canthus areas.

2- Magnesium sulphate group (M): (25 patients).

They received 9 ml of the local anesthetic: 4.5 ml of 0.5% bupivacaine and 4.5 ml of 2% lidocaine mixed with hyaluronidase (150 U) and 50 mg magnesium sulfate in 1 ml

of 0.9% saline which were divided equally in both inferotemporal and medial canthus areas.

3- Rocuronium group(R): (25 patients).

They received 9 ml of the local anesthetic: 4.5 ml of 0.5% bupivacaine and 4.5 ml of 2% lidocaine mixed with hyaluronidase (150 U) and 0.06 mg/kg rocuronium (maximum 5 mg) in 1 ml saline which were divided equally in both inferotemporal and medial canthus areas.

4-Dexmedetomidine group: (25 patients).

They received 9 ml of the local anesthetic: 4.5 ml of 0.5% bupivacaine and 4.5 ml of 2% lidocaine mixed with hyaluronidase (150 U) and 1 mcg /kg dexmedetomidine in 1 ml saline which were divided equally in both inferotemporal and medial canthus areas.

All patients in each group received (9ml) of a mixture contain 2% lidocaine and 0.5% bupivacaine in combination with 150 IU hyaluronidase and 1 ml of normal (control group) saline or additive in saline for other groups (magnesium sulphate, rocuronium and dexmedetomidine).

4-Assessments: The following were assessed:

The success of the block: It was evaluated by scoring the mobility of the globe and the eyelid and by assessing corneal anesthesia using a small piece of cotton wool at 2.5, 5, 7.5, and 10 min after injection.

Motor block : Evaluation included the following:

Evaluation of lid akinesia: (lid closure and squeezing by orbicularis and lid opening by the levatorpalpebrae muscle) using a three-point scale (0–2) in which:

- 1) 0 refers to complete akinesia.
- 2) 1 refers to partial movement in either or both eyelid Margins.
- 3) 2 refers to normal movement in either or both eyelid margins.

For assessment of lid akinesia, the patients were asked to open their eyelids and then squeeze them together maximally.

Evaluation of globe akinesia: It was done using a three-point scale (0-2) for each of the four cardinal directions (upward, downward, nasal, and temporal) (Total score of 8).

Ocular movement in each direction was scored as:

- 1) 0 if there is no directional movement.
- 2) 1 if it is limited.
- 3) 2 if it is normal.

A total score of 10 was obtained when we add the globe akinesia score (0–8) and the lid akinesia score (0–2).

Table (1): Ocular movement score

Ocular movement	Score
Normal full movement	2
limited movement	1
No movement	0

Corneal anesthesia score: assessing corneal anesthesia was done by using a small piece of cotton wool at 2.5, 5, 7.5, and 10 min after injection.

Onset Time: (defined as the presence of corneal anesthesia together with an ocular movement score 1 or below in every direction and an eyelid akinesia score of 0) were recorded using a stopwatch.

RESULTS

The current study was carried on 100 patients divided into four equal groups: first group (control group), second group (dexmedetomidine group), third group (magnesium sulphate group) and fourth group (rocuronium group). All patients were scheduled for surgery.

Assessment of motor blockade:

Globe akinesia:

Evaluation of the globe akinesia was done at (2.5), (5), (7.5), and (10) min. after injection as shown in table (2). The onset of motor block showed a statistically significant difference between the four groups ($P < 0.05$). At the 2.5 minute, the rocuronium group showed more rapid onset of motor block (6.32 ± 0.63) then dexmedetomidine group (7.20 ± 0.65) then magnesium sulphate group (7.56 ± 0.65) then lastly the control group (9.04 ± 0.68).

At the fifth minute, the rocuronium group showed more rapid onset of motor block (4.04 ± 0.98) then dexmedetomidine group (4.68 ± 0.48) then magnesium sulphate group (5.04 ± 0.45) then lastly the control group (5.68 ± 0.95).

At the 7.5 minute, the rocuronium group showed more rapid onset of motor block (0.80 ± 0.76) then dexmedetomidine group (1.80 ± 0.82) then magnesium sulphate group (3.28 ± 1.14) then lastly the control group (4.28 ± 1.31).

At the tenth minute, the rocuronium group showed more rapid onset of motor block (0.12±0.33) then dexmedetomidine group (2.16±2.27). (0.56±1.04) then magnisum sulphate group (0.80±1.87) then lastly the control group (2.16±2.27).

Table (2): Comparison between groups according to globe akinesia

Globe Akinesia	Group (DEX) (N=25)	Group (ROC) (N=25)	Group (Mg) (N=25)	Control (N=25)	ANOVA	p-value
Globe Akinesia 2,5 Mean±SD Range	7.20±0.65 6-9	6.32±0.63 5-8	7.56±0.65 7-9	9.04±0.68 7-10	76.016	<0.001
Globe Akinesia 5 Mean±SD Range	4.68±0.48 4-5	4.04±0.98 3-5	5.04±0.45 4-6	5.68±0.95 5-8	20.578	<0.001
Globe Akinesia 7,5 Mean±SD Range	1.80±0.82 1-5	0.80±0.76 0-2	3.28±1.14 1-5	4.28±1.31 2-6	56.038	<0.001
Globe Akinesia 10 Mean±SD Range	0.56±1.04 0-5	0.12±0.33 0-1	0.80±1.87 0-5	2.16±2.27 0-5	7.863	<0.001

Corneal anesthesia:

Evaluation of the corneal anesthesia was done at (2.5), (5), (7.5), and (10) min. after injection as shown in table (3). The onset of sensory block showed a statistically significant difference between the four groups (P<0.05). At the 2.5 minute, the dexmedetomidine group showed more rapid onset of sensory block (20 patients) then magnisum sulphate group (19 patients) then rocuronium group (17 patients) then lastly the control group (8patients).

At the 5 minute, the dexmedetomidine group showed more rapid onset of sensory block (24 patients) then magnisum sulphate group (22 patients) then rocuronium group (21 patients) then lastly the control group (19 patients).

At the 7.5 and 10 all patients had corneal anathesia and there was no difference between all four groups.

Table (3): Comparison between groups according to corneal anesthesia

Corneal Anesthesia	Group (DEX) (N=25)	Group (ROC) (N=25)	Group (Mg) (N=25)	Control (N=25)	x2	p-value
Corneal Anesthesia 2,5 No pain Pain	20 (80.0%) 5 (20.0%)	17 (68.0%) 8 (32.0%)	19 (76.0%) 6 (24.0%)	8 (32.0%) 17 (68.0%)	15.625	<0.001
Corneal Anesthesia 5 No pain Pain	24 (96.0%) 1 (4.0%)	21 (84.0%) 4 (16.0%)	22 (88.0%) 3 (12.0%)	19 (76.0%) 6 (24.0%)	4.319	0.229
Corneal Anaesthesia 7,5 No pain	25 (100.0%)	25 (100.0%)	25 (100.0%)	25 (100.0%)	0.000	1.000
Corneal Anesthesia 10 No pain	25 (100.0%)	25 (100.0%)	25 (100.0%)	25 (100.0%)	0.000	1.000

DISCUSSION

Several studies have compared the effect of adding different types of additives to improve the quality of block in ophthalmic local anesthesia with varying results⁽¹⁰⁾.

Adding neuromuscular blockers to the local anesthetic does not affect analgesia but induces akinesia in extraocular muscles which helps optimizing the setting for ophthalmic surgery. The dose of rocuronium chosen in this

study was less than one-tenth the dose administered intravenously for clinical neuromuscular blockade. Since this dose is used frequently as a priming dose, it can be considered safe⁽¹¹⁾

With the introduction of phacoemulsification techniques, it is currently possible for cataract surgery to be successfully performed using topical anesthesia, reducing

the clinical relevance of complete motor block. However, many ophthalmic surgeons prefer to operate on immobile eyes, and akinesia still remains of interest for many ophthalmic surgical procedures. In addition, a recent study suggested that patients prefer peribulbar block to topical anesthesia during cataract surgery⁽¹²⁾.

Dexmedetomidine is a highly specific centrally acting α_2 -agonist commonly used as sedative, preemptive analgesic and to maintain stable hemodynamics in laparoscopic surgeries. It can also be added to the local anesthetic mixture in peripheral nerve block, brachial plexus block, subarachnoid anesthesia, and ophthalmic anesthesia⁽¹³⁾.

The process by which α_2 -adrenergic receptor agonists cause sedation and analgesia is not fully understood but it is most likely multi-factorial. α_2 -agonists produce analgesia peripherally by decreasing the release of norepinephrine and also by an α_2 -receptor-independent inhibitory effect on nerve fiber action potential. They produce analgesia centrally, by inhibiting the release of substance P in the nociceptive pathway at the level of the dorsal root neuron as well as by activation of α_2 adrenoceptors in the locus coeruleus⁽¹²⁾.

Magnesium has numerous physiological activities including activation of many enzymes involved in energy metabolism and protein synthesis. It blocks calcium influx and noncompetitively antagonizes NMDA receptor channels. In addition, it has postsynaptic calcium channel blocker properties and has been used successfully to potentiate opioid analgesia and treat neuropathic pain in animals⁽¹⁴⁾.

The present study reported that no significant difference was found in hemodynamic changes (heart rate, mean arterial blood pressure, peripheral oxygen saturation) in all groups. This result agrees with that of the study conducted by **Hamawy and Bestarous**⁽¹⁵⁾ on 75 patients to compare between single injection peribulbar block of local anaesthetic mixture, local anesthetic mixture with 0.6 mg/kg rocuronium and local anesthetic mixture with 50 mg magnesium sulphate.

In our study, the rocuronium group (R group) showed a better akinesia score compared to the dexmedetomidine group then magnesium sulphate group and control groups. In contrast,

onset akinesia was more rapid, leading to less delay in surgery and more suitable conditions to operate in less than 10 min, also reinforced by the fact that the rocuronium group needed less dose of supplemental injection, reducing the rate of complications that may be attributed to repeated.

The study by **Aissaoui *et al.***⁽¹⁶⁾ demonstrated that the addition of rocuronium to a local anesthetic mixture in peribulbar block provides good akinesia and reduces the need for supplementary injections of local anesthetic. Similarly, **Abdellatif *et al.***⁽¹⁷⁾ added a low dose of rocuronium to two different concentrations of local anesthetic mixture and concluded that a mixture of rocuronium 5 mg, lidocaine 2%, and bupivacaine 0.5% provides optimal orbital and eyelid akinesia for cataract surgery and shortens the block onset time. Again, **Hamawy and Bestarous**⁽¹⁵⁾ compared the addition of rocuronium or magnesium sulfate to the local anesthetic mixture (bupivacaine/lidocaine/hyaluronidase) and concluded that adding rocuronium to the local anesthetic mixture results in a better akinesia score and faster establishment of suitable conditions to start cataract surgery compared to the addition of magnesium to the same mixture.

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